THE ROLE OF PASSIVE MOBILIZATION IN THE IMMEDIATE MANAGEMENT OF THE FRACTURED NECK OF HUMERUS

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Conservative management, including an early introduction of pendular exercises to prevent shoulder stiffness, has always been advocated in the treatment of the fractured neck of humerus. However, the problem of glenohumeral joint stiffness can still be present many weeks after the fracture. It was proposed that the inclusion of passive mobilization in the treatment programme could lessen this problem. A method of passive mobilization which could be begun within the first few days post fracture, was used in a pilot study of 14 patients with fractures of the neck of humerus. Initial results indicated that with the inclusion of passive mobilization in an active treatment programme, good functional results could be obtained, while the period of rehabilitation and the number of treatments could also be substantially reduced.

Because fractures of the proximal end of the humerus occur predominantly in the older age group (women being affected twice as often as men), Horak *et al.* (1975) assign them a prominent place in the category of bone fragility fractures. These fractures are not uncommon in adolescents where fracture separation of the upper humeral epiphysis occurs (Apley, 1977).

Conservative management of these fractures is strongly advocated by Böhler (1975) and Lusser *et al.* (1975). Lusser *et al.* (1975) demonstrated that conservatively managed fractures consistently showed better long-term results in shoulder movement and function than those managed surgically. This management not only applied to those fractures which were impacted, but to those which demonstrated considerable displacement of the fragments. While Böhler (1975) has advocated surgical intervention for the adolescent slipped epiphysis, Campbell *et al.* (1975) report that, despite marked displacement of the fragments, the posterior part of the periosteum remains intact. This maintains fragment proximity and provides a mould for the callus to form medially.

Conservative management normally consists of support of the arm in a sling with or without a form of binder. The long-term problems of the fractured neck of humerus are not those of mal-union or non-union, but of glenohumeral joint stiffness, and as Müller (1976) reported, prolonged immobilization only aids tissue fibrosis which leads to joint stiffness. As a result, early mobilization to help counter this problem is universally advocated. The emphasis of this immediate management has been directed towards gravity assisted pendular exercises for the shoulder (Böhler, 1975; Eberle *et al.* 1975; Müller, 1976; Apley, 1977), and active exercises for the elbow, wrist and fingers. Despite commencement of these exercises within the first week post fracture, problems of residual joint stiffness can frequently be encountered clinically, many weeks after the fracture. For this reason the period of rehabilitation is often prolonged and less than satisfactory results have sometimes to be accepted.

Such problems emphasize the need for the use of a more effective method of retaining full range of glenohumeral movement and decreasing pain, so that the condition of the joint is as ideal as possible for the resumption of active control of movement. It has been postulated that passive mobilization could serve this need in the initial stages of treatment, when both the pain and the recent fracture inhibit voluntary movement throughout the full glenohumeral range.

This paper describes a proposed method of treatment using passive mobilization and presents the preliminary results of a trial to evaluate its effectiveness.

THE TREATMENT

Before embarking on any treatment programme, it is first necessary to understand the nature of the patient's presenting problem. When seen within the first week following fracture, the patient may still have some pain even with the sling support. It is commonly felt over the lateral aspect of the upper arm and may radiate down to the elbow. The patient frequently complains of pain on unguarded movement and may experience some pain at night. Various degrees of oedema and bruising become evident in the first week following fracture. This gravitates down the upper arm to the elbow, usually more on the medial surface. The patient is usually very apprehensive, reluctant to move and has total loss of function of the upper arm.

For this reason, during the initial interview, it is important to explain the potential prob-

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lems of shoulder stiffness and how they can be avoided by early movement. It is necessary to reassure him, and, most importantly, to gain his confidence in your management.

As explained to the patient, the problem of the glenohumeral joint is one of great potential for loss of movement due to pain and the trauma of the soft tissues at the time of fracture. This problem is enhanced by the necessary initial periods of immobilization in the sling, and the lack of functional use resulting from muscle inhibition due to pain from the joint and fracture site.

The aims of treatment, therefore, in this initial stage are:
- to decrease pain and retain movement of the joint;
- to prevent organization of the haematoma;
- to institute a home programme of early movement;
- to discuss personal hygiene and functional activity with the patient.

In the proposed method of treating fractured necks of the humerus, passive mobilization is advocated as a means of decreasing pain and retaining movement. Under more normal circumstances, pain may be managed by passive mobilization through the performance of relatively large amplitude accessory movements in the neutral position of the physiological ranges of the joint. Stiffness may be treated passively, by small amplitude physiological and accessory movements performed at the limit of range of the joint. When treating fractured necks of humerus these basic principles are modified. Larger amplitude accessory movements are used to aid in decreasing pain, but are performed close to the limit of available range. They are alternated with a gentle physiological movement to move the joint further into the physiological range.

The most important, and perhaps the easiest movement to regain initially, is abduction. The techniques performed at the commencement of this treatment are an accessory antero-posterior, postero-anterior glide, alternated with a very gentle physiological abduction. For convenience, techniques described here refer to a fracture of the right humerus.

The presence of a recent fracture dictates that hand positioning is such that the head, the fracture site and the shaft of the humerus are well supported and move as one unit. The physiotherapist's hands must in essence supply external splintage to the fracture site whilst movements are performed.

The physiotherapist's right hand is gently moved as high as possible into the patient's axilla so that the thumb supports the head of humerus anteriorly and the index finger posteriorly. The remaining fingers and palm support the fracture site and the shaft of the humerus. The thumb and index finger of the left hand support the anterior and posterior surface of the head of humerus from the lateral aspect, the remaining fingers and palm likewise cupping the fracture site. The distal end of the shaft is supported on the physiotherapist's thigh, while the patient's forearm and hand are supported between her side and right arm. (See Figure 1.)

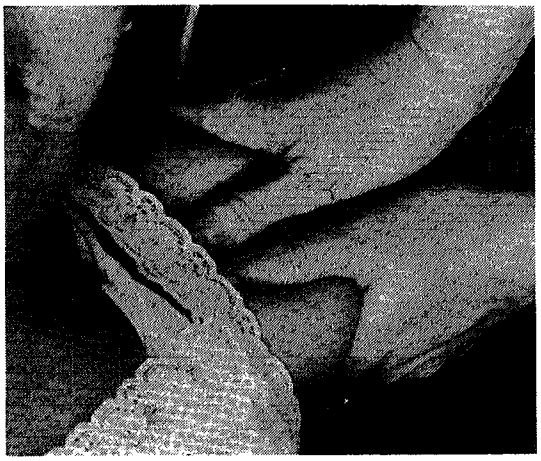

FIGURE 1: HAND POSITION FOR ANTERO-POSTERIOR POSTERO-ANTERIOR GLIDE IN ABDUCTION.

In treatment, the patient's arm is very slowly abducted with the physiotherapist's thumbs and index fingers guiding the movement of the humeral head and feeling through her fingers and palms, for any movement of the shaft not corresponding to movement of the head. Pain and spasm are the major guides and, at the first sign of either, abduction is ceased. The relatively large amplitude accessory movements of antero-posterior postero-anterior glides are then performed, while ensuring that the shaft and head are moved in unison, to prevent any shearing at the fracture site. Once pain and muscle spasm have subsided, the humerus is again gently moved into the abduction range until halted at the first sign of pain or spasm.

This gentle process is repeated until the abduction range is approximately 90°. Assisted active adduction-abduction movements are now performed through the newly acquired range. The therapist's support of the patient's humerus remains unaltered during these exercises.

Once the goal of 90° abduction has been achieved, a second accessory movement of longitudinal glide is added. For this technique the physiotherapist's hand placements are altered slightly and the right hand is spread further into the axilla so that the medial sur-

face of the humerus has a broader support. The thumb and index finger of the left hand are now placed on the antero-superior and postero-superior surfaces of the head of the humerus, on either side of the acromion (Figure 2).

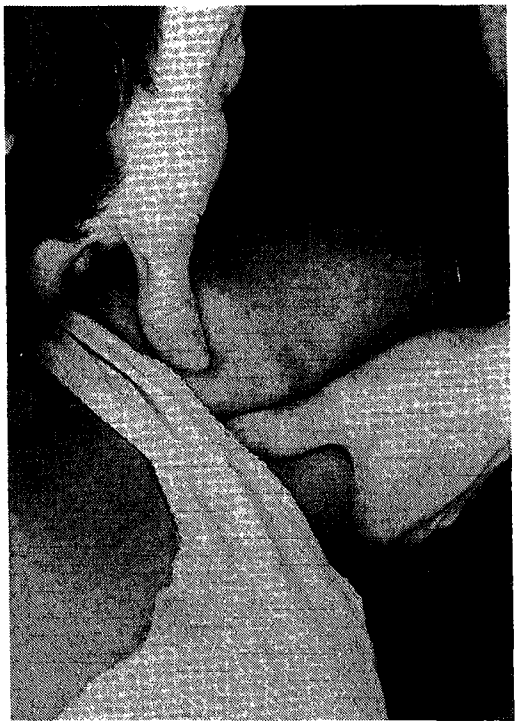

FIGURE 2: HAND POSITION FOR LONGITUDINAL GLIDE IN ABDUCTION.

The initial movement is a pure longitudinal movement produced by the thumb and index fingers, with full support and comparable movement occurring at the shaft via the therapist's right hand and thigh support. Eventually this technique can be progressed to longitudinal movements with slight abduction of humerus. Progression is guided by the patient's pain and can usually be achieved by the third treatment.

When 90° of abduction has been gained, the treatment is directed towards also retaining flexion. The arm is transferred from the position of 90° abduction to 90° flexion. If performed carefully this manoeuvre can often be achieved in the first treatment session. However, if there has been a slow progression into abduction, or if the slightest movement of the fracture site is felt to have been detected, flexion may not be achieved until the second or the third treatment.

The manoeuvre of transferring to flexion in itself is quite simple, but it requires well co-ordinated movement by the physiotherapist. The patient's arm is gently transferred so that the forearm is supported between the therapist's left arm and side. The hand position is changed so that both thumbs support the head of humerus in the axilla with the index fingers posteriorly. The shaft of the humerus is supported by the therapist's right forearm. The humerus, with full support, is elevated to 90° flexion.

The two accessory movements of antero-posterior, postero-anterior glide and longitudinal glide to the head of the humerus are once again used to retain and regain the flexion range. Both movements are performed with similar hand grips. The head of the humerus is supported anteriorly and posteriorly by the therapist's thumbs and index fingers respectively. Once again, the other fingers and palms firmly grip the proximal shaft of the humerus. In order to support the shaft of humerus, the patient's forearm is supported by the therapist's waist, and for further stability very gentle pressure is applied down the length of the shaft (see Figure 3).

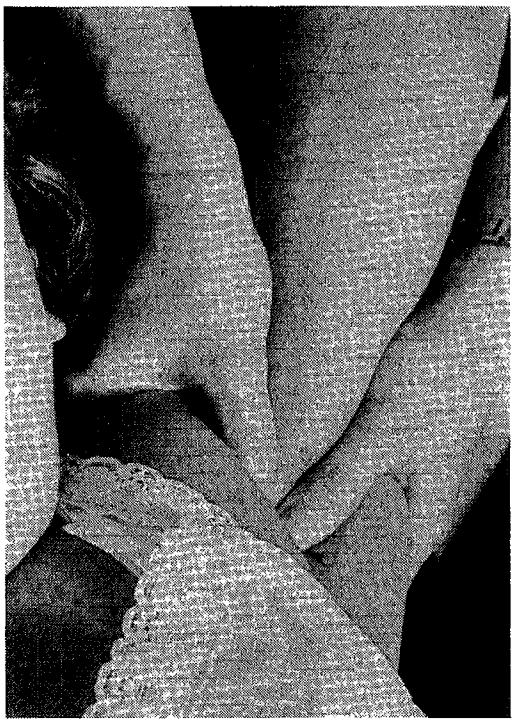

FIGURE 3: HAND POSITION FOR ACCESSORY MOVEMENTS IN FLEXION.

The accessory movements are performed alternately, as relatively large amplitude movements. When there is no pain or spasm, the range of flexion is gently increased. The accessory movements are then repeated. This process is continued until as much flexion range as is

possible is regained in each treatment session. A very useful range gaining technique to intersperse with the passive movement, is a relaxation technique for the shoulder adductors and extensors. This technique is incorporated in the treatment without change in hand position.

At the conclusion of the initial treatment, the patient is very carefully instructed in a home programme of gravity assisted pendular exercises for the glenohumeral joint. The patient is encouraged to remove the arm from the sling every hour to perform these exercises. At the same time, exercises are performed to maintain full elbow movement, particularly extension. The wrist and hand movements are retained by early resumption of light functional activity. It is important to ensure from the outset that the patient can manage such functional activities as personal hygiene and dressing.

In the following treatments this programme of passive movement is repeated with the aim of retaining the range of movement and regaining any range that has been lost. The sling support is gradually discarded as the pain decreases and the patient resumes light functional activities. This usually occurs within a period of two weeks post fracture.

Although one particular treatment regime of passive mobilization has been described here, as with all physiotherapy treatments, techniques may have to be adapted to suit the individual needs of a patient, particularly in the light of the nature and stability of the fracture. Maitland (1977) has described other modified techniques which may be used especially in the very early stages if the arm cannot be abducted from the side. In one patient included in this study who had sustained a non-impacted fractured neck of humerus, longitudinal movements performed by thumb pressures on the superior aspect of the head of humerus while the patient performed pendular exercises, proved to be valuable in the very early stages.

THE STUDY

To evaluate the effectiveness of this form of treatment, an investigation was commenced within the Physiotherapy Department of the University of Queensland. To date, only the pilot clinical study has been completed and this paper presents details of that stage of the ongoing project.

Subjects

Patients were referred from two orthopaedic clinics to the Physiotherapy Department of the Royal Brisbane Hospital, where the project was undertaken. Subjects were included in the study if they had sustained a fracture of the proximal end of the humerus within 14 days of referral for physiotherapy, the interval varying between 1 and 14 days (Table 1). All patients were accepted into the study regardless of accompanying history and treated basically in the same way.

Days Post Fracture	Number of Patients
1	1
2	1
3	2
4	1
5	–
6	1
7	1
8	1
9	2
10	–
11	1
12	–
13	–
14	3

TABLE 1: DISTRIBUTION OF INTERVALS BETWEEN FRACTURE AND COMMENCEMENT OF TREATMENT.

Fourteen subjects were referred for physiotherapy over a period of six months, nine of them aged between 58 and 80, and five aged between 13 and 17 years. For the purposes of comparison, the subjects have been classified according to age grouping as 'older' and 'younger'. The distributions of age and sex are presented in Table 2 and it is interesting to note that this data is similar to that reported in the literature (Apley, 1977). Of the 10 fractures of the surgical neck of humerus, seven were reported as impacted with two showing minor displacement and three were not impacted. Both fractures of the greater tuberosity were slightly displaced, while of the two slipped upper humeral epiphyses, one also presented with an avulsion of a metaphyseal fragment.

Three of the older patients had associated problems: rheumatoid arthritis with previous flexion range of 140°, shoulder pain following earlier Colles fracture, and limited flexion of 170° following a similar fracture two years previously.

Age	Sex		Type of fracture of proximal end humerus					
			Surgical neck		Gtr. tuberosity		Slipped epiphysis	
(Years)	Male	Female	M	F	M	F	M	F
13-17	2	3	1	2	0	3*		
58-80	1	8	1	6			1	1

* one patient sustained fractures of both the surgical neck and the greater tuberosity of the humerus

TABLE 2: DISTRIBUTION OF AGE, SEX AND TYPE OF FRACTURE.

Procedure

Each patient was assessed thoroughly and details of pain, haematoma, functional limitations and history of incident were recorded. Although characteristically the fracture is most commonly caused by a fall on the outstretched hand, few patients could recall the exact mechanism of injury. Attempted active glenohumeral flexion was assessed, and in 12 cases there was no initiation of movement. In the remaining two cases, one younger patient had 70° flexion (referred nine days post fracture) and an older patient with a fracture of the greater tuberosity of the humerus had 50° flexion (referred eight days post fracture). The range of elbow movement was also assessed. In four patients referred within 9 to 14 days post fracture, a loss of extension ranging from 20°-35° was recorded. In those patients who were referred for earlier management only a minimal loss of extension was found in five patients. This range was regained by the end of the first or second treatment. Explanations of the nature of, and problems associated with these fractures were given to each patient, and a treatment programme initiated according to the individual patient's needs. Although an occasional variation in approach was necessary, all patients were treated using the mobilization procedures described earlier, as well as a programme of active re-education introduced at appropriate times. Treatments were given three times each week, and patients were given a suitable home programme, adapted continuously to meet the changing needs of each patient.

RESULTS

Passive abduction range

As outlined in the description of treatment method, passive glenohumeral abduction was the first movement treated. A minimum of 90° abduction was regained during the first treatment in 11 of the 14 patients. In the remaining three patients it was regained by the third treatment.

Passive flexion range

Treatment of the flexion range was begun during the first treatment in 10 subjects. Of the remaining subjects, it was begun during the second treatment in one subject, the third in two subjects and the fourth treatment in the remaining subject. Because of the hand positioning for support of the humerus during the performance of passive movements in flexion, approximately 175° flexion could be regained passively in the early stages of rehabilitation. The time taken to regain this flexion covered a wide range. To cite the extremes, it was regained during the third treatment (5 days post fracture) in one younger subject, while in the other male subject who had sustained a previous fracture of his neck of humerus, his 'normal' flexion of 170° was not regained until the fifteenth treatment (6.5 weeks post fracture). After fracture, the mean days and treatment for the patient to regain 175 degrees flexion were for the older group, 27.2 days, 9.7 treatments, and for the younger group, 16.0 days, which constituted 5.0 treatments.

Active flexion range

During treatment assisted active exercises were commenced immediately. Active and subsequently resisted active exercises were added as soon as possible. Figure 4 shows the averaged time period of return of antigravity flexion.

In the older group, resumption of substantial antigravity range occurred between the fourth and the sixth weeks. In the younger group, it

occurred between the third and fourth week. These figures relate well with the process of osteogenesis, fractured necks of humerus displaying clinical union at 3 weeks and consolidation at 6 weeks (Apley, 1977).

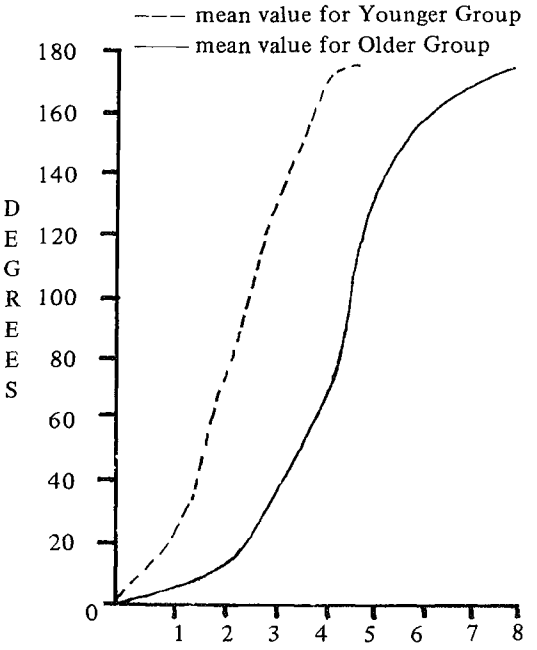

FIGURE 4: TIME OF RETURN OF ANTI-GRAVITY FLEXTION.

The elbow

The immediate commencement of both active and passive movements of the upper limb appears to prevent problems of elbow stiffness and organization of the haematoma, for these problems were not present in patients referred for immediate management. Of the four patients with initial lack of elbow extension, movement was regained with relaxation techniques to the biceps.

Discharge

The criteria for discharge were resumption of normal pain-free function of the arm and resumption of normal active glenohumeral range of movement.

With reference to these criteria, provided normal function was pain free, pain at the extreme of range was accepted. A residual loss of 5° to 10° flexion and a lack of external rotation of 10° to 15° was likewise accepted, if and when necessary.

The accepted criteria for discharge were fulfilled in all but two patients. The patient with rheumatoid arthritis regained the range of movement she felt she had prior to fracture (140° flexion). At 4 weeks post fracture she was discharged as an inpatient and returned to her home in the country. At this stage she had assisted active control of this range. Because of these circumstances she has been deleted from the further results of this study. The second patient's active range of flexion plateaued at 150° flexion. She considered that she could function normally at home and this compromise result was accepted.

Table 3 shows the week post fracture in which patients were discharged. The mean period post fracture for the older group was 7.5 weeks, and that of the younger group was 5 weeks. The average number of treatments performed in the older age group was 20, while that of the younger group was 10.

	NUMBER OF PATIENTS	
Week Post Fracture	Younger Group	Older Group
4	2	–
5	1	1
6	2	–
7	–	2
8	–	3
9	–	1
10	–	1

TABLE 3: WEEK POST FRACTURE IN WHICH PATIENTS WERE DISCHARGED.

Follow-up

Patients were reviewed 2 months after discharge. To date, eight patients have been reviewed, four from each age group. All patients reported resumption of normal pain-free function, while the four younger patients had returned to playing sport. Two patients did complain of problems with the functional movement of hand behind back, one of these patients also complaining of slight aching with weather changes. The range of movement at review as seen in Table 4 demonstrates that patients had maintained or slightly improved their range of movement following discharge.

TABLE 4: RANGE OF SHOULDER MOVEMENT AT DISCHARGE AND AT TWO MONTH REVIEW (N = 8).

Range of Movement	Shoulder Movement Number of Patients					
	Flexion		Abduction		External Rotation	
	Discharge	Review	Discharge	Review	Discharge	Review
Full	3	5	3	5	1	4
Loss of $0^o - 5^o$	3	1	3	1	3	1
Los of $5^o - 10^o$	2	2	2	2	3	2
Loss of $10^o - 15^o$					1	1

DISCUSSION

In view of the facts that in this study treatment was commenced very early for both impacted and non-impacted fractures, the question of whether passive movement of the glenohumeral joint can be performed with safety must be posed. The hand positions for the techniques supplied the greatest possible support of the fracture site and techniques were always guided by the patient's pain, being ceased when definite pain or spasm was encountered. Nevertheless, even with every precaution being taken, there could be no guarantee that slight movement did not occur at the fracture site during treatment. Sarmiento *et al.* (1976) have reported extensive work on functional bracing of fractures, including forearm and Colles fractures and more recently fractures of the shaft of humerus (Sarmiento *et al.*, 1977). This bracing allows early functional use of the joints adjacent to the fracture site. From their extensive experience, the authors claim that rigid immobilization of fractures is not a prerequisite for fracture healing, and that in the closed treatment of long bone fractures, mobilization of adjacent joints does not militate against healing. In fact, functional activity during treatment favours osteogenesis.

As there were no problems of fracture union encountered during the rehabilitation of the patients in this trial, it is postulated that if the treatment did produce slight movement of the fracture site, it was not detrimental to osteogenesis.

Clinical union of these fractures occurs in three weeks and this appears consistent with the initial resumption of definite rotator cuff activity and the commencement of anti-gravity control. At this stage of treatment, the emphasis was shifting very rapidly from the passive to the active role and the active programme was intensified. The home programme must be continually adapted to suit the changing status of the patient. Consolidation of the fracture occurs in approximately six weeks and, as was seen in Figure 4, this was commensurate with the resumption of good functional anti-gravity range.

An extensive study on early functional management of subcapital humeral fractures, involving 213 patients, was reported by Müller (1976). After a period of 5 to 7 days of immobilization, patients were treated with pendular exercises three times per week. After 3 weeks, these exercises were progressed to above shoulder level. The average number of treatments given by Müller to his patients was 37, the majority of patients being discharged in a period of 8 to 16 weeks post fracture. Initial results of the present study indicate that, with the introduction of passive mobilization in the early management of these fractures, the number of treatments and the period of rehabilitation can be significantly reduced. The mean number of treatments in the older group (20) and in the younger group (10) compare favourably with Müller's (1976) mean of 37, while the mean treatment times of 7.5 weeks and 5 weeks for the older and younger groups respectively in this study are much briefer than the 8-16 weeks reported by Müller.

In a 10 year follow up of his patients, Müller determined that 86% were pleased with the late results of movement, though a few had functional difficulties such as during hanging washing or combing hair; 75% had no significant

complaints of pain. In the 2 month follow up of this study results which are at least comparable to Müller's appear to be emerging. A larger sample size will allow a more thorough analysis of long term results of the management programme advocated here.

CONCLUSION

The initial results of introducing early passive mobilization in the total management of the fractured neck of humerus are very favourable in comparison to present conventional management. For the patient, rehabilitation to a good functional level is completed in a shorter time and from an economic viewpoint, the reduction in treatment time has definite advantages. Because this small sample size prevented the control of variables in this initial study, the question of the optimal time post fracture at which treatment should be commenced cannot be answered.

Other factors in the total management of the fractured neck of humerus also warrant further investigation. Such possibilities as the role of interferential therapy in pain reduction and in hastening osteogenesis, and the best methods of facilitating active movement to further hasten rehabilitation must still be studied. It is hoped that an expansion of this trial will provide some of the answers.

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